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# Fast simulation methods in ATLAS: from classical to generative models

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The ATLAS physics program relies on very large samples of GEANT4 simulated events, which provide a highly detailed and accurate simulation of the ATLAS detector. However, this accuracy comes with a high price in CPU, and the sensitivity of many physics analyses is already limited by the available Monte Carlo statistics and will be even more so in the future. Therefore, sophisticated fast simulation tools are developed. In Run-3 we aim to replace the calorimeter shower simulation for most samples with a new parametrized description of longitudinal and lateral energy deposits, including machine learning approaches, to achieve a fast and accurate description. Looking further ahead, prototypes are being developed using cutting edge machine learning approaches to learn the appropriate calorimeter response, which are expected to improve modeling of correlations within showers. Two different approaches, using Variational Auto-Encoders (VAEs) or Generative Adversarial Networks (GANs), are trained to model the shower simulation. Additional fast simulation tools will replace the inner detector simulation, as well as digitization and reconstruction algorithms, achieving up to two orders of magnitude improvement in speed. In this talk, we will describe the new tools for fast production of simulated events and an exploratory analysis of the deep learning methods.

## Consider for promotion

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